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A STUDY OF THE EFFECT OF STORAGE, HEAT, AND MOISTURE ON PYRETHRUM

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INTRODUCTION

It has been generally accepted by entomologists that pyrethrum powder deteriorates rapidly under ordinary conditions of storage, but few or no data have been advanced to support this theory or to show under what conditions or how rapidly such deterioration takes place. The following experiments, made at the testing laboratory of the Insecticide and Fungicide Board of the United States Department of Agriculture, Vienna, Va., were conducted to ascertain the effect of exposure to heat, moisture, and the weather, and of storage in sealed glass containers, on whole and ground flower heads of *Pyrethrum cinerariaefolium* (Trev.).

METHODS OF TESTING

Two methods of testing the pyrethrum powder were used: (1) By dusting and (2) by dipping.

In the dusting tests small potted nasturtium plants, grossly infested with aphids (*Aphis rumicis* Linnaeus), were thoroughly dusted by means of a small hand dust gun.

In the dipping tests large specimens of the German roach or Croton bug (*Blattella germanica* Linnaeus) were dropped into a beaker containing a small amount of the pyrethrum powder to be tested, and the beaker was given a shake so that the insects were thoroughly covered with the powder. Each roach was then placed in a separate 8-ounce bottle and observed at frequent intervals, the time when the insect became inactive, i. e., unable to walk, and the time of death

being recorded. With each set of experiments checks, consisting of 10 roaches dipped in fresh pyrethrum powder and 10 untreated, were used. The average mortality for the untreated roaches was found to be less than one roach in 108 hours, which is so small that the untreated series were omitted from the following tables.

EFFECT OF EXPOSURE TO WEATHER AND IN A ROOM

Table I shows the killing effect on roaches of whole and ground flower heads that had been exposed to the weather or in a room for various periods of time.

TABLE I.—*Effectiveness against roaches of whole and ground pyrethrum flower heads exposed to the weather or in a room. Ten roaches dipped for each test*

No.	Material.	Exposed—	Number of weeks.	Hours required to kill.		
				First roach.	Last roach.	Average.
1	Whole flower heads	To weather	2	19.3	43.3	31.2
2	do	do	12	19.6	92.1	34.6
3	do	do	21	23.2	3 active at end of 120 hours.	
4	Ground flower heads	do	2	19.5	64.5	35
5	do	do	12	19.6	47.6	29.8
6	do	do	21	23.4	4 active at end of 120 hours.	
7	Whole flower heads	In room	2	24.	64.8	43.1
8	do	do	12	19.8	92.3	39
9	do	do	21	[1] 4.5	71.9	31
10	do	do	34	22.4	67	40.7
11	do	do	150	18	44.5	22
12	Ground flower heads	do	2	19.5	64.5	39.5
13	do	do	12	19.7	43.9	26
14	do	do	21	[1] 6.1	27.5	22
15	do	do	34	22.1	46.5	36.4
16	do	do	136	26.1	1 active at end of 120 hours.	
17	do	do	150	42.1	8 active at end of 120 hours.	
18	Whole flower heads	In sealed jars	150	17.5	41.5	25.2
19	Ground flower heads	do	2	19.3	43.3	36.2
20	do	do	12	19.9	44	27.4
21	do	do	21	23.5	47.5	30.7
22	do	do	34	18.3	46.9	35.2
23	do	do	136	22.3	46.3	28
24	do	do	150	17.9	44.1	21.9

[1] Probably injured in dipping.

The material used in these experiments was received as whole flower heads in April, 1915, when it was divided into six lots which were treated as follows:

No. 1. Whole flower heads, in a large open glass cylinder, were placed out of doors where they were fully exposed to the sun, wind, and rain.

No. 2. Powdered flower heads, sifted to 80 mesh, were exposed as in lot No. 1.

No. 3. Whole flower heads were placed in a shallow dish and allowed to stand on a shelf in the laboratory.

No. 4. Powdered flower heads (80 mesh) were exposed as in lot No. 3.

No. 5. Whole flower heads were kept in a tightly sealed fruit jar in the laboratory.

No. 6. Powdered flower heads (80 mesh) were kept as in lot No. 5.

At the times indicated in the table portions of these six lots were ground, sifted to 80 mesh, and tested against roaches by dipping the insects as described on page 1.

This table shows that an exposure to the weather for 12 weeks does not noticeably injure ground or whole flower heads, but that an exposure of 21 weeks materially reduces the efficiency of both, since at the end of this time they killed, in 120 hours, only 60 and 70 per cent, respectively.

When whole flower heads were exposed in an open dish in the laboratory for 150 weeks, they retained their full efficiency. Under the same conditions the powdered flower heads showed some deterioration in 136 weeks, and were of almost no value at the end of 150 weeks. Both flower heads and powder showed no loss of efficiency when kept in tightly closed jars for 150 weeks.

EFFECT OF STORAGE IN SEALED GLASS CONTAINERS

Tables II and III give a comparison of the effectiveness against aphids and roaches of whole and ground pyrethrum flower heads stored in glass containers for 5½ years.

The materials considered in these tables were received as whole flower heads in 1911. A portion of each sample was ground early in 1912 and stored in a tightly stoppered bottle. The remaining flower heads were stored in sealed fruit jars under the same conditions until March, 1918, when a portion of each lot was ground and tested in comparison with the powders prepared in 1912.

TABLE II.—*A comparison of the effectiveness against aphids of whole and ground pyrethrum flower heads stored in glass containers for 5½ years. One nasturtium plant, grossly infested with aphids, dusted in each test*

No.	Material.	Number of tests.	Ground in spring of 1912; tested March, 1918.	Number of tests.	Ground and tested, March, 1918.
1	California flowers	4	Ineffective	4	80–90 per cent killed or repelled.
2	Montenegrin flowers	4	do	4	80–95 per cent killed or repelled.
3	Dalmatian flowers	4	do	2	90 per cent killed or repelled.

TABLE III.—*A comparison of the effectiveness against roaches of ground and whole pyrethrum flower heads stored in glass containers for 5½ years. Ten roaches dipped for each test*

No.	Material.	Ground in spring of 1912, tested March, 1918—Hours required to kill roaches.	Ground and tested in March 1918—Hours required to kill—		
			First roach.	Last roach.	Average.
1	California flowers	7 killed in 120 hours	18.5	44	32
2	Montenegrin flowers	5 killed in 120 hours	18.9	72.8	36.7
3	Dalmatian flowers	6 killed in 120 hours	19.5	72	40.3

As will be noted in Table II, the powders ground in 1912 were ineffective in 1918, when tested against nasturtium aphids. Whole flower heads from the same stock, which had been kept in sealed fruit jars for 5½ years and were ground in 1918, killed from 80 to 90 per cent of the treated aphids. Fresh pyrethrum tested at the same time killed 90 per cent.

Table III gives the results of dipping tests against roaches with the same materials as used in Table II. In every case the powders ground in 1918 were found to be effective, all of the roaches being killed in from 32 to 40.3 hours, while in no case did the powders ground in 1912 kill all of the dipped roaches in 120 hours. Fresh pyrethrum, used at the same time, required on the average 31.3 hours to kill 10 roaches. These tests show that pyrethrum powder kept in tightly stoppered bottles for 5½ years loses practically all of its effectiveness, but that the unground flower heads stored under the same conditions for the same length of time are practically unhurt.

Table IV shows the effect, on powdered flower heads, of 5½ years' storage in tightly stoppered bottles or sealed glass fruit jars.

TABLE IV.—*A comparison of the effectiveness against nasturtium aphids of freshly ground Dalmatian closed flower heads and of the same powder after it had been stored in tight glass containers for 5½ years. One nasturtium plant, grossly infested with aphids, dusted for each test*

No.	Material.	Crop of—	Dalmatian closed flower heads ground in spring of 1912.					
			Tested November, 1912.			Tested March, 1918.		
			Number of tests.	Length of tests.	Results.	Number of tests.	Length of tests.	Results.
				Days.			*Days.*	
1	Wild flowers	1908	1	1	98 per cent killed.	4	7	Ineffective.
2	do	1909	2	2	95–100 per cent killed.	2	7	Do.
3	do	1910	2	4	99 per cent killed.	2	7	Do.
4	Cultivated flowers	1908	2	2	100 per cent killed.	4	7	Slightly effective.
5	do	1909	2	2	do	2	7	Ineffective.
6	do	1910	[1] 2	1	do	2	7	Do.

[1] The cabbage aphis (*Aphis brassicae* Linnaeus) was used in these tests.

The materials used in these tests were received in 1911 as whole flower heads, which were ground and sifted in the spring of 1912, and stored in sealed fruit jars or tightly stoppered bottles. These powders were tested against nasturtium aphids in November, 1912, and again in March, 1918.

As will be noted, all of these powders were found to be effective in November, 1912, and of almost no value in March, 1918. It is therefore evident that pyrethrum powder stored in sealed glass containers for 5½ years will lose practically all of its efficiency.

In connection with the deterioration of unground flower heads, it is of interest to note that, in the 1912 tests, practically no difference in effectiveness was found between the 1908, 1909, and 1910 crops, which indicates that the flower heads are not noticeably injured in four years under the commercial conditions of storage.

EFFECT OF SOAKING IN HOT OR COLD WATER

Table V shows the effectiveness against roaches of pyrethrum powder which had been soaked for 24 hours in hot or cold water.

TABLE V.—*Effectiveness against roaches of pyrethrum powder soaked for 24 hours in hot or cold water. Ten roaches dipped in each test*

No.	Treatment.	Hours required to kill.		
		First roach.	Last roach.	Average.
1	Check, untreated	21.7	35.9	25.9
2	Soaked in cold water	21.9	48.2	38.9
3	Soaked in hot water	[1] 2.5	1 living at end of 94 hours.	

[1] Probably injured in dipping.

The material used in test No. 1 was prepared by soaking 20 grams of pyrethrum powder (80 mesh) in 100 c. c. of cold water for 24 hours. The water was then filtered off and the powder dried at room temperature and resifted to 80 mesh.

The material used in test No. 2 was prepared in the same way, boiling water being used.

This table shows that pyrethrum soaked for 24 hours in cold water killed all of the dipped roaches in 48.2 hours, but required on the average 13 hours longer to kill than did the untreated powder. The pyrethrum treated with hot water killed only 9 roaches in 94 hours. It is therefore evident that cold water removes some of the active ingredients from pyrethrum powder, but not as much as is removed by hot water.

EFFECT OF EXPOSURE TO DRY HEAT

Table VI shows the effect on ground flower heads of exposure to dry heat for 18 hours.

TABLE VI.—*Effectiveness against roaches of pyrethrum powder exposed to dry heat for 18 hours. Ten roaches dipped in each test*

No.	Temperature.	Hours required to kill.		
		First roach.	Last roach.	Average.
1	Check, unheated	20.5	39.6	31.0
2	120° C.	19.6	43.6	30.9
3	120° C.	21.1	47.4	27.8
4	130° C.	1 dead in 48 hours.		
5	140° C.	None dead in 48 hours.		

The materials used in these tests were placed in open tubes and heated for 18 hours at the temperature given. The results show that an exposure to a temperature of 120° C. (248° F.) for 18 hours does not noticeably injure pyrethrum powder, but that a temperature of 130° C. (266° F.) or 140° C. (284° F.), for the same length of time, either destroys or drives off the active principle.

SUMMARY

1. Whole and ground flower heads kept in sealed fruit jars for 150 weeks were not injured.

2. Ground flower heads kept in tightly closed glass containers for 5½ years lost practically all of their effectiveness.

3. Whole flower heads kept in tightly closed glass containers for 5½ years were practically unhurt.

4. Whole flower heads exposed in an open dish in a room for 150 weeks were not injured.

5. Ground flower heads were not injured by an exposure for 34 weeks in an open dish in a room. Their value was materially reduced by an exposure of 136 weeks and they were practically worthless at the end of 150 weeks.

6. Whole and ground flower heads were uninjured by an exposure to the weather of 12 weeks, but an exposure of 21 weeks greatly reduced their efficiency.

7. Powdered flower heads heated at 120° C. for 18 hours were practically uninjured, but a temperature of 130° or 140° C. for the same length of time destroyed practically all of their effectiveness.

8. Ground flower heads were slightly injured by soaking for 24 hours in cold water, and materially injured by soaking for the same length of time in hot water.

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